

The Snowdens' Iron Works

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“there are very great conveniences of carrying on Iron Works within this Province, which have not hitherto been embraced for want of proper encouragement to some first undertakers,”

Preamble of an Act of the Colony of Maryland Assembly, 1719.

“Yesterday Morning Died, at his Seat on Patuxent River, near his Iron-Works, in the 76th Year of his Age, the venerable Mr. Richard Snowden..”

Maryland Gazette, Annapolis, January 27, 1763. p.3

Introduction

This book traces the history and technology of several Irons works in pre-colonial Maryland, starting with the Colony of Maryland. The collected information is the result of a long chain of research by tireless researchers in dingy colonial era archives, and in dismal swamps.

Author

Mr. Patrick H. Stakem has researched and written about significant iron manufacturing facilities in Western Maryland, including Lonaconing and Mount Savage. Living adjacent to the Snowden Mansion “Montpelier”, and finding significant amounts of iron ore in his own yard, he began to research the Snowden facilities. Recently, he uncovered another Snowden Iron Works, being excavated in Brownsville, PA. No connection between the two Snowdens has yet been found, beyond the fact that the Montpelier Snowden came from Wales, and the Pennsylvania one came from Scarborough, England (1818).

Snowden in Maryland

Richard Snowden (16xx-1711) was born and died in England. He had married Deborah Abbit, and had a child, Richard. Richard

(1666-1724) was also born and died in England. He married Elizabeth Green, and may have been a Major in Cromwells' Army. He had a son, Richard.

In 1658, Major Richard Snowden, of Wales, moved to the Colony of Maryland, seeking new opportunities. He came as an indentured servant. In the 1600's, Maryland was not a great place to live, as residents had a 10 year shorter lifetime than New Englanders, due to Malaria and Typhoid.

Richard had a son, Richard, born in 1666. He later served as a Captain of Provincial Forces, militia, from 1700-1703.

That Richard had a son, Richard (1688 to 1763), who was referred to as the "Iron Master."

The original Snowden built iron furnaces on the South River, which rises near Crofton Maryland, and flows 10 miles to the Chesapeake Bay. This was the ideal location for transportation. In those days, ships heading to the colonies were ballasted with bricks, which were then sold for local construction. Brickmaking hadn't developed in the Colonies yet. Returning ships would use rock, or pig iron from the furnaces as ballast. Being from Wales, Richard Snowden was familiar with the processing of iron ore, and iron production in general.

A rich iron ore deposit had been discovered in the area. The first settlers made very little use of the ore until samples were sent to England in 1718 for testing, and were rated very favorably. Snowden had bought his land originally from George Yate in 1679. The ore was bog iron, and near the Chesapeake, there was abundant limestone in the form of sea shells. The area was heavily forested, so there was a good source of fuel for the furnaces. This facility was abandoned later, possibly because the ore ran out. He moved westward, following the Patuxent River.

In 1686, Richard Snowden Sr. was granted *Robin Hood's Forest* by King Charles II and patented through Lord Baltimore, a tract of 10,500 acres. It was located on the east side of the current

Baltimore-Washington Parkway, between Maryland Routes 197 and 198. Actually, the parkway construction cut through what once was his property. The outlines of the buildings can be seen at the site with difficulty, and the Snowden cemetery is preserved to the east of the Parkway. The Patuxent River flowed through the property, and was navigable to the Chesapeake Bay. This provided a path for trade and commerce.

The manor built by Richard Snowden Jr. was of brick construction with shingle siding. A central hall was surrounded by fireplaces. A semicircle of barns held tobacco crops. A boxwood garden led to the family cemetery. By 1790 the estate composed 10,000 acres.

A large part of the estate later became Fort George G. Meade and the Patuxent Wildlife Research Center. The Baltimore-Washington Parkway was built through the plantation site.

One of the first iron works in Maryland was organized by Richard Snowden III on September 29, 1736 on the Patuxent River near what is now the Baltimore Washington Parkway, to the east, between MD routes 197 and 198. This was the Patuxent River Iron Works Company, with Snowden in partnership with Joseph Cowman and three other partners. (ref, Lewis, Ronald L. p. 24) Some stone foundations can still be found east of Brock Bridge Road but these are probably from a later grist and saw mill which operated on the site. The furnace was built on the North side of the Patuxtent, at the Old Forge Bridge, near Portland Station (currently in Odenton, MD). Richard Jr. died in 1763 and Richard Sr. then divided the iron works between three sons, John, Thomas, and Samuel Snowden, Richard Sr. was also called the "Iron Master" as his iron mines and facilities were a going concern in the area for quite some time.

By 1754, there were seven furnaces and eight forges, producing 2,500 long tons (2240 lbs) of pig iron, and 600 of bar iron yearly.

Joseph England, Ironmaster of the Principio Furnace in North-East

Maryland, had a partial interest in the Snowden facility. Principio, was built in 1719. It was destroyed by British forces in 1813. Can't have those pesky colonists building cannon.

Another furnace and forge, the Snowden Iron Works, was operated on the Little Patuxent River near the Old Forge Bridge and was eventually sold by Thomas, Richard, and Edward Snowden to Evan T. Ellicott and Company. They built a second furnace, a puddling furnace, and roughing mills at the site. The footings of the original Old Forge Bridge can be found just west, or upstream, of the current wood and iron bridge near Tipton Airport on the Little Patuxent River. The Patuxent River, an Indian name which means "running over loose stones", was known locally as Snowden's River because the family owned so much land on either side. It was in use as a means of commerce to get iron and tobacco to the bay, and bring back finished goods from England.

Sea shells from the bay were shipped back to the iron works to be used as flux. Much later, 3,000 tons per year of limestone were sent from Baltimore to the Patuxent Iron works via Annapolis Junction for use as flux. It is assumed that much of the pig iron went north to Industrial Baltimore. To this day, shipments of limestone rock flows from Pennsylvania through Baltimore on the railroad to Annapolis Junction. It is used in construction and for concrete production.

Major John Welsh was an iron merchant, partner along with his cousin Richard Snowden, son of Richard and Elizabeth.

Overview of iron making

Iron ore is, essentially, rust. You do not melt it in a furnace. The trick to getting useful iron is to remove the bonded oxygen. To get really useful iron, you also have to remove the impurities. This is usually done with a fluxing agent, calcium carbonate, such as shells or limestone, when they are heated together in a furnace.

The English and the Welsh were making iron in the 1700's along

with most technologically advanced countries. The Welsh had ore and coal, but lacked good transportation options. The English had to buy ore, chiefly from Russia, and pay for it in gold. The English saw a new option, in the Colonies, where iron ore and coal were abundant, close to the sea. The colonists saw a big business opportunity. Iron Masters, and skilled laborers found their way to the Colonies, and pig iron found its way back, mostly as ballast on supply ships. The English supported the pig iron making facilities of the Colonies by providing money and know-how. What they did not want was the Colonists making finished products for themselves, like bar iron, or heaven forbid, cannon balls. The Colonists wanted to make their own products, and did not want to be taxed. This eventually lead to a situation in which the Colonists wanted to be Independent. The English resisted this, and even burned some of the Iron Making facilities they had paid for in the Colonies. In the end, things did not turn out according to their plan.

Pig iron is the product of smelting iron ore with coke or charcoal using limestone as a flux. Pig iron has a very high carbon content, typically 3.5–4.5% which makes it very brittle and not useful directly as a material except for limited applications. It is a good first step, but has to be reworked unless you just want a cook pot or cannon ball. Pig iron is so called because of the arrangement for tapping the furnace. You need enough heat to get to 2797 degrees F. The Welsh had the process working on an industrial scale by the 1600's. They couldn't measure temperature, but the Iron Master could tell from the color.

At a forge, a blacksmith could produce bar iron or wrought iron from pig. Pig iron is reheated and cast into molds for pots and firebacks. Wrought iron is used for tools, horseshoes, and other finished products.

There is evidence from along the Patuxent River, which was passable to the Chesapeake Bay in Snowden's time, of small batch crude iron manufacture using simple sealed crucibles of iron ore and sea shells (for flux). These were placed in a wood fire for days,

maybe a week. When they cooled, they were broken open, and, with luck, the iron had separated from the slag. Slag is brittle, so it could be hammered away. The clay pot was tapered at the end, some what like a Greek Amphora, to sit upright in the fire. A friend of mine found one of these in his backyard, which abuts the Patuxtent in Bowie.

There is also a small batch process using a short clay furnace known as a bloomery. It is charged with the iron ore, flux, and charcoal, and when it is finished, you have a bloom of iron and slag, called sponge iron. This is worked by heating and hammering, until most of the slag has been removed. Sometimes, this operation was done in a clay-lined pit, with a chimney above. It was possible to use a bellows to speed up the process. The iron never really melts, as the furnace operates at a lower temperature, and thus the added step of hammering the bloom. The amount of charcoal is critical, because if too much carbon enters the iron, it cannot be worked. The bloomery process does not require flux.

The blast furnace process of producing iron requires a ready source of iron ore, limestone, a fuel, and a blast. The preferred fuel is coke, nearly pure carbon, made from coal. Early furnaces used charcoal, which requires a lot more fuel, and does not burn as hot. The preferred blast is heated air, but cold blast was used in the early furnaces. The “blowing engine” was typically a bellows arrangement, powered manually, or by a water wheel. So the ideal spot is a location near to iron ore, heavily forested, with river access to the sea. Just like where Snowden's property was located. The lack of abundant local limestone was offset by having the boats bring back shells from the shore. They're the same basic stuff as limestone, which is formed in part from ancient marine life.

A flux is used to collect the impurities from the ore. Wood was burned into charcoal on site in long covered pits. The process of extracting iron from ore is a chemical reduction process. The carbon from the charcoal or coke binds with the oxygen from the iron oxides in the ore, and goes off as carbon dioxide and carbon monoxide. The iron ore was roasted before being introduced into

the furnace. This served to remove some contaminants present in the raw ore, which affected the strength of the iron. Siderite (iron carbonate), in particular, will kill the fire due to released carbon dioxide, if introduced directly into the furnace. Siderite can be found in bog iron, which forms from iron in solution in the water. Limonite, another iron ore, is also bog iron. In fact, the name, from the Greek, means “wet meadow.”

The traditional shape of the molds used for these ingots was a branching structure formed in sand, with many individual ingots at right angles to a central channel or runner. Such a configuration is similar in appearance to a litter of piglets suckling on a sow. When the metal had cooled and hardened, the smaller ingots (the pigs) were broken off the much thinner runner (the sow), hence the name pig iron. As pig iron was intended for remelting, the uneven size of the ingots and inclusion of small amounts of sand was insignificant compared to the ease of casting and of handling.

Pig iron is then remelted and a strong current of air is directed over it while it is being stirred or agitated. This causes the dissolved impurities (such as silicon) to be thoroughly oxidized. The metal is then cast into molds or used in other processes.

Raw Materials and byproducts

Iron melts at 2797 degrees F. Actually, it freezes at 2797 degrees F as well. But cast iron, or pig iron is at best an intermediate product. It is not strong in tension, and not suited for many applications beyond casting simple implements. The follow-on process makes wrought iron from pig. Small batches of wrought iron can be produced from pig iron by a blacksmith at a forge. Larger production requires a different type of furnace. The British did not want the Colonists to manufacture derivative products from pig iron. They wanted the colonists to send all their pig iron to England, for value-added processing that could be sold back to the Colonists.

Iron Ore

Captain John Smith is generally credited with the discovery of iron ore in Maryland in 1608. There is no evidence that the Native American population ever smelted ore, although they did use it as a pigment. George Washington's father was involved in one of the earliest colonial-period iron industries.

There are different types of iron ore, chiefly Hematite, Limonite, Siderite, and Magnetite. The ore that Snowden used was probably local Siderite. Siderate is iron carbonate, FeCO_3 . This is found in swamps or bog, and referred to as "bog iron."

The Arundel Formation is a very clay-rich sedimentary rock, dating from the Early Cretaceous period (100-146 million years ago). It is a source of iron ore, and fossils.

There are large pit mines along both sides of Muirkirk Road in Prince Georges County, now mostly full of water. One of these is called "Blue Pond." Over at the Dinosaur Park off of Contee Road, there are some very large pieces of iron ore to be seen.

In fact, the Maryland State dinosaur's (*Astrodon johnstoni*) remains were found in the iron pits. There was a much later iron facility at Muirkirk, near the present day MARC Station.

Flux

The fluxing agent for the blast is usually limestone, or marine shells, which were found along the Chesapeake Bay. Both are forms of calcium carbonate (CaCO_3), from marine organisms. The fluxing agent removes impurities from the iron, and cools to a material called slag. Slag is usually glassy, and has different colors, depending on the impurities. It's mostly a waste material, but can be used for roadbeds.

Fuel

The fuel for the furnace is either charcoal, or coke. Charcoal is the result of burning wood in a controlled oxygen environment. Mostly

any vegetable matter will work. This can be accomplished by covering the fire with dirt, or roasting the wood in an enclosed oven, a process called pyrolysis. The idea is to get rid of everything but the carbon. Charcoal can burn at up to 2700 degrees C, and is essentially pure carbon, with some impurities. When we apply this same process to coal, we get coke. Coke production is labor intensive.

Slag

Slag is the glassy material, where the flux has trapped the impurities in the original ore and from the charcoal or coke. The primary components of iron slag are limestone (CaO) and silica (SiO_2). Other components of blast furnace slag include alumina (Al_2O_3) and magnesium oxide (MgO), as well as a small amount of sulfur (S).

Blast

Blast refers to forced induction of air to the furnace to produce a hotter burn. This can be done with a hand- or water-powered bellows, or a water or steam engine powered “blowing engine.” The bellows produces puffs of air, whereas the blowing engine can produce a steady draft. The blast enters the furnace through nozzles called “tuyeres.” These can be water-cooled to prevent melting. The inducted air is heated first before entering the furnace, which enhances the process. Steam can be used to enhance the burning process, as well.

Bringing it all together

The furnace can be operated continuously, as liquid iron and slag are drawn off at the bottom, then the tapping holes are re-plugged with clay. The furnace is “charged” or filled at the top, which is why many furnaces were built against a hillside. The continuous process is efficient, since the furnace doesn’t cool and need to be reheated. Generally, a furnace will last about a year, before it has to

be rebuilt or relined. If there was no convenient hill, a ramp would be used to allow men with wheelbarrows to charge the furnace.

In the simpler cases, a furnace is charged, allowed to burn out, and recharged. This would be done if there is no convenient way to get wheelbarrows of the raw material to the top. More than likely, the earlier facilities of Snowden's were operated this way.

Timeline

1608 Captain John Smith finds iron ore along the Patapsco River in the Colony of Maryland, sends two barrels to England.

1632 Maryland Colony chartered by King Charles I to Cecil Calvert, 2nd Lord Baltimore.

1634 First permanent settlement in Maryland.

1640 (?) Richard Snowden is born in Wales.

1650 – Colonial William Burgess, an English Merchant, brings 150 settlers to the Colony of Maryland. Settled on the “South River Hundred.”

1658 Richard Snowden moves to the Colony of Maryland. In other news, the Taj Mahal is completed, and Oliver Cromwell dies.

1665 – 1,800 acre land grant to Jerome White. Becomes White Hall.

1669 Jerome White sells land to Yate. Yate sells to Snowden and Linthicum. They are growing tobacco and making iron.

1675 – Linthicum sells his portion to Snowden.

1686 King Charles II, through Lord Baltimore, grants Snowden Sr. 1976 acres on the Puxtuxent River, *Robin Hood's Forest*.

1690 Richard, Jr. builds *Birmingham Manor* House on the Old Post Road in Robin Hood's forest. This manor house would later burn in 1891, with the loss of many Snowden family papers. Richard Snowden III, to be called the Ironmaster, is born.

- 1691 Richard Snowden marries Mary Linthicum
- 1705 Richard Snowden, Jr. and three partners build an iron furnace along the Patuxent, near his home according to the 1763 “Articles of Agreement” dated July 5, 1705, and filed in Maryland.
- 1711 Richard Snowden, Sr. dies.
- 1719 General Assembly of Maryland passes an act to encourage iron manufacture.
- 1733 Richard Snowden, III (grandson of Major Snowden) partners with John Welsh as iron merchants.
- 1734 An improved facility is built at a possibly different site along the Patuxent.
- 1736 Patent granted to Snowden Iron Works by Colony of Maryland, Richard III.
- 1745 Despite being a Quaker, Snowden had 45 enslaved workers, based on tax records.
- 1753 Charles Carroll of Annapolis noted that Snowden's Works was the only one in Maryland to have ore near navigable waters. Richard Jr. dies.
- 1763 Snowden, Sr. (the Iron Master) divides the Iron works between sons John, Thomas, and Samuel. Richard Sr. dies.
- 1765 Brownsville, PA, along the Monongahela River is settled.
- 1776-1783 American Revolution.
- 1794 State of Maryland map shows Snowden iron facility at the Big Patuxent branch at Brock Bridge Road (west of the Baltimore-Washington Parkway), and another on the Little Patuxent at Forge Bridge, on the East side of the Parkway.
- 1798 Federal District Tax, Anne Arundel County, assessed \$816. on Snowden & Co. for 204 acres of property including a forge.

- 1801 Maryland Iron Works shuts down after operating since 1775.
- 1803 Thomas Snowden dies.
- 1818 John Snowdon arrives in Brownsville, PA from England.
- 1820 Snowden Iron Works (Maryland) constructed.
- 1825 Turnpike between Baltimore & Washington finished; (5-6 hour) journey; would become U. S. Rt. 1.
- 1831 Maryland Iron Works sold to Evan T. Ellicott. Another iron furnace (28 feet x 8 feet), a puddling furnace, and roughing mills were added. Iron bars were made and shipped to the Avalon works near Relay, MD.
- 1835 B&O Railroad Washington Branch opens; travel time cut to 2 hours between Baltimore & Washington (except at rush hour).
- 1836-1839 Dunlop's Creek Bridge constructed in Pennsylvania by John Snowdon's Vulcan Iron Works, under contract to the Army Corps of Engineers. His son is listed as part of the Company.
- 1856 Maryland Iron works shut down and demolished.
- 1860 – Martinet Map shows a “Works Bridge” over the Big Patuxent at the current Brock Bridge Road, near a blacksmith shop and a forge.
- 1861 Civil War begins. Naval Battle at Hampton shows the value of iron ships.
- 1864 John Snowdon partners with Mason to build the Iron Clad ship USS Manayunk (also called Ajax). They construct a facility in Pittsburgh.

1865 Snowdon and Mason build the Iron Clad USS Umpqua.

1878 Hopkins Map shows Maryland Iron Works, Grist & Saw Mill at the same location as the forge site, 1860.

1939 - Julius & Estelle Snowden are living in a bungalow on the site of Birmingham Manor.

1941 – Birmingham Manor site becomes part of Fort Meade.

1947 Baltimore-Washington Parkway constructed, cutting across some of the original Snowden Estates.

1991 Maryland Iron Works and Birginham Manor site is found, on the Patuxent Wildlife Refuge North Tract east of the Baltimore-Washington Parkway, between Maryland Routes. 197 and 198.

The Maryland Iron Works

Snowden(s) were involved in at least three Maryland iron-making facilities, between 1679-1856. These are discussed below. Anne Arundel County, Maryland currently has more than 25 identified iron deposit sites.

South River Works

Originally, Richard Snowden (the first immigrant) built iron furnaces on the South River, on the Western shore of the Chesapeake Bay. This was ideal for transportation. Iron ore was abundant in the area, and crushed sea shells were used for the flux. There were extensive forests to supply the wood for charcoal.

The original land patent was to Jerome White of St. Mary's Co., a 500 acre parcel. The part he sold to Snowden, called Iron Mine, was in Anne Arundel Co. "at the head of South River on the west side of the south branch of the river and the north side of land now in possession of George Nettlefould," This 500 acre plot was

known as “White's Hall.” White sold this plot to John Yate in 1669. Later, the home that was the birthplace of Johns Hopkins would be built here. It is still standing.

Snowden, and business partner Thomas Linthicombe purchased the plot of land from George Yate in January of 1669. It was sold for 11,000 pounds of tobacco, from Snowden, and an indenture for Linthicombe's half (presumably for 11,000 pounds of tobacco or equivalent).

Later in 1675, Linthicum sold his share to Snowden, in consideration of 6,000 pounds of tobacco.

The tract of land was known as the South River Hundred, or “the iron mine.” It was bounded by Whites Hall. Snowden and his partner, Linthicombe, were both listed as “planters.” A “Hundred” was a term used by the British to describe a parcel of land that could supply 100 men as militia, as needed.

At this point, we have to acknowledge the efforts of the Colony of Maryland, later, the State of Maryland, in preserving these documents, circa 1650-1794 and making them available. Even more remarkable, the originals were lost in a court house fire in 1704, but were re-recorded. Unfortunately, the original maps and drawings were lost.

The earliest production facility was probably a simple bloomery, a technology used since prehistoric times. Iron ore and charcoal are mixed in a small hearth, and a bellows is used to increase the temperature. A bloomery give you a big chunk of iron, which is re-heated and hammered. Bloomery iron is relatively soft, and can be fashioned by a blacksmith at a forge. It has a low carbon content, and can be easily bent. A bloomery is relatively inefficient, but was easy to set up and operate in remote locations. It would have been adjacent to a charcoal facility. A lot of manual labor is involved in the process.

Coke is preferred to charcoal as a fuel, but you take what you can get. Charcoal is formed from heated wood, and coke is formed

from heated coal. There is not much evidence of coal in the eastern end of Maryland, along the western shore of the Chesapeake Bay.

Patuxent Iron Works

Richard Snowden, III, Joseph Cowman, Edmund Jennings, John Galloway, and John Pritchard started the Patuxtent Iron Works as shown in the Articles of Agreement, dated July 5, 1705, and registered with the Colony of Maryland. Eventually, Cowman and Jennings were bought out by the other partners.

The company had some 45 enslaved persons, serving as foremen, founders, general laborers, and blacksmiths, according to tax records.

In 1831, after the furnace and forge were sold to Evan T. Ellicott & Company, they erected a second furnace, some 28 feet high and 8 feet wide at the boshes. A water-powered blast was used, later being replaced by a steam blast. They also built a puddling furnace and a roughing mill. These converted the pig iron to bar. The facility produced around 1200 tons of pig iron a year, His product went to the Avalon Mill near Relay, MD for further processing.

In 1748, an agreement between Richard Snowden and Joseph Cowman for the operation and possibly expansion of the iron works was made. Snowden conveyed ten thousand pounds of tobacco and one hundred acres of land. There is mention of land from Thomas Linthicum and Edward Gaither, as well as slaves, horses, and wagons. (from Maryland Provincial Court Land Records of 1749, Maryland State archives).

In a 1753 correspondence, Charles Carroll of Annapolis mentioned the facility was the only one in Maryland near navigable waters. (Maryland Geological Survey, Vol. 9 p. 270)

The facility was closed in 1856, due to shortages of ore and wood in the area. As mentioned in the Maryland Geological Survey of

1911, ruins were still visible at the site.

In 2009, the Lost Towns Project began excavating a site known as Pig Point, near Edgewater, MD, thought to be named for the iron bars or “pigs” made by Patuxent Iron Works and shipped downriver to merchant vessels from this point. Located on private property in Anne Arundel County, the site has also revealed a vast array of American Indian artifacts, showing that it was continuously occupied for at least 9,500 years.

Snowden Iron Works

The Snowden Iron Works was located on the East side of the current Baltimore-Washington Parkway, north of Maryland Route 197. It was operating by 1734. The Snowden mansion here was called Birmingham House. It burned, and only the outline of the foundation remains. At the site, which is controlled access, is the Snowden Cemetery, and some other outlines that may be associated with the iron works, or barns.

In 1831, Thomas, Edward, and Richard Snowden sold the furnace and associated forge to Evan T. Ellicott and Company, who operated the facility and the Avalon Forge, which was located in the present Patapsco Valley State Park. The pig iron for the forge came from the Snowden facility. They made nails and iron hoops for barrels. The Works employed 360 workers. The furnace had a water-powered blast, at 1.25 pounds per square inch pressure. Annual output reached 1200 tons, but the eventual lack of wood for charcoal, and ore caused the facility to close. It was dismantled in 1856.

There is an 1860 map showing a “works Bridge” over the Big Patuxent at Brock Bridge Road, with blacksmith shops near a forge.

The Iron Workers

Snowden's Furnaces in Maryland were worked by a variety of

men. The knowledgeable iron master knew what and how much to put in the furnace, and when to take the iron out. There was no instrumentation except calibrated eyeballs. Potential iron masters had done all the manual jobs, and then apprenticed to a Master.

Most good Iron Masters came from Wales, which had a long history of Iron Making. In the Western end of Maryland, a furnace was erected in Lonaconing and staffed with Welsh Immigrants.

There was a lot of heavy labor to be done at the furnaces. Trees had to be cut, trimmed, and made into charcoal. Iron ore had to be dug, and shells brought from the Chesapeake for the flux. The furnace had to be carefully tended, under the watchful eyes of the iron master. When he judged the iron process was complete, the furnace would be tapped at a clay plug, and the liquid iron would run out into channels, and cool.

There were various levels of workers. The Snowdens', in spite of being Quakers, were slave holders. In addition, there were indentured servants, who, just like Richard, came to the Colonies, and worked to pay off their passage. Then there were the convicts, mostly prisoners from various British wars, particularly the Jacobite Rebellion. In 1650, Scottish prisoners from the Battle of Dunbar were sold into indentured servitude for a period of 6-8 years. There were also salaried employees, like the iron master, who did the skilled work. The iron furnace needed constant repairs to its masonry. It was intensive work, particularly if human-operated bellows were used.

The role of Underwater archaeology

Maryland shipped pig iron to England as ballast in the sailing ships of the time. Up to 90% of the iron produced in Maryland went to England. Maryland, and the colonies in general, were prohibited from producing more complete products from their pig iron. That was reserved for the mother country, who sold the bar iron, nails, and such back to the colonies.

Occasionally, some of the ships never made it home. If they sunk mid-voyage, they were lost, but if they sank in less deep coastal waters, they would be recoverable after the invention of scuba gear. One such find was the vessel L'Aimable Grenot, that sank in 1749 off St. Malo, a port city in Brittany. It contained 50 tons of pig iron ballast, marked “Potuxent, 1747.” Were the colonists providing iron to England's enemy, or was the L'Amimable a privateer, preying on English shipping? Another find of Maryland iron was on the East Indiaman *Griffin*, in the Sulu Sea, off the Philippines, which was wrecked in 1761.

In the 1800s and early 1900s, the Arundel clays in Prince George's County were mined for siderite iron ore. Iron furnaces located throughout the region melted down siderite (Iron Carbonate, FeCO_3) to produce iron used in construction and manufacturing. In 1858, African American miners working in open pit mines (probably along Muirkirk road) were the first to discover dinosaur fossils in Maryland. Siderite is 48% iron, and has no impurities such as sulfur or phosphorus, which “poisons” the iron.

Iron production moved to the Western End of the State, in Allegany County, where there was abundant sources of ore, limestone, and coal. In addition, local fire-clay would be used to line the furnace to increase its life. The facility at Mount Savage would go on to produce the first iron rail manufactured in the United States, breaking the British monopoly.

The Pennsylvania Snowdon Iron Works

There had been a recent breakthrough discovery by the Society for Pennsylvania Archaeology, Mon-Yough Chapter #3, in Brownsville, Pa. They announced that they have located and begun excavation of the Snowdon's Vulcan Iron & Machine Works in the Town, in 2012. Connection between the Maryland Snowdens and the Pennsylvania Snowdon is not known, except their iron making.

In 1818, John Snowdon arrived in Brownville from Yorkshire, England. He apprenticed at a local foundry, and opened his own

machine shop and rolling mill. He produced steam engines for the river boats, including the *Monongahela* in 1827. The facility was extended in 1831, but burned in 1853. The replacement facility included a forge, rolling mill, pattern shop, foundry, and finishing shop on an acre of land on the bank of the Mon. The buildings were now constructed of brick.

To quote from Thurston's 1859 Town Directory,

"Within its walls and distributed over the use of two rooms, with nice regard to their convenient use, is gathered a large amount of machinery, of the latest improvements, adapted to all the requirements of machine manufacturing; among them are 19 turning lathes, 6 planning machines, 4 boring machines and 8 drill presses. There upon the lower floor, 10 blacksmith fires, with all of their accompanying cranes, steam forge hammers, and etc."

The First Iron Bridge in America

Brownsville, Pennsylvania is the site of the Nation's first iron bridge, the Dunlop's Creek Bridge, along the National or Cumberland Road, built west from Cumberland, Maryland, to the Ohio. Cumberland was already linked to the Port of Baltimore by a State-financed Road, and would be connected to Baltimore by the B&O Railroad in 1842, and to Washington by the C&O Canal in 1850.

The National Road was constructed 1811-1818, under the order of President Thomas Jefferson, as part of a larger plan of "Internal Improvements." The National Road provided access to the Ohio River, at Wheeling, West Virginia (and later extended to Zanesville, Ohio) from the Eastern Seaboard.

Dunlop's Creek proved a difficult area to bridge. The iron bridge was at least the fifth attempt. When the first attempt was lost in an 1808 flood. Judge James Findley, a local and "the Father of Modern Suspension Bridges" built a new bridge in 1809. It collapsed during a snow storm in 1820, taking a wagon and team with it.

The first two timber bridges at this location “collapsed under extreme weather conditions” in 1808 and 1812. The third timber bridge was in bad enough shape by 1832 that the Army Corps of Engineers specified an iron bridge. The design was supplied by Captain Richard Delafield. He was influenced by French iron bridge design, and his training was from West Point, which taught Civil Engineering practices. Rather than another ill-fated wooden bridge or a masonry structure, Delafield pushed for an Iron bridge. It hadn't been done in the U.S. as of then, and he wanted to be the first to do it. In 1843, it was referred to as “the most splendid piece of bridge architecture in the United States.”

The bridge covers 80 feet in one span with an 8 foot rise, and was constructed in 1836-39. The wrought iron for the bridge was supplied by the Vulcan Iron Works, owned and operated by John Snowdon, in Brownsville. The bridge has survived to this day, and is in current use. According to the Historic American Engineering Record (HAER) report, this is probably due to the high quality of the iron. A new bridge on Route 40 spans the Monongahela just north of the Dunlop's Creek Bridge. Brownsville dedicated its Town park to Mr. Snowdon.

The cast iron used in the construction was from the Herbertson Foundry in Brownsville, using Ohio pig iron. There were 250 castings, and over 300,000 pounds of iron were used, not including the floor plates. Brownsville had the largest concentration of foundries anywhere along the road, except possibly for Wheeling, for steamboat construction. The manufacturing facilities and the skilled craftsmen were available locally for the bridge project. It was built with standardized, interchangeable, factory-manufactured parts, and constructed on-site. The American Society of Civil Engineers describes the five arched ribs of the bridge as “tubular sections that closely resemble the cylinders being made at the time for steamboat engines.”

The bridge survives, and carries traffic to this day, with no weight restrictions. It now has a new concrete deck, and steel I-beam supports have been added. It is listed as a National Historical Civil

Engineering Landmark. Nice job, Captain Delafield, and Mr. Snowdon

In 2014, the 175 year-old bridge underwent a renovation by the Pennsylvania Department of Transportation. The bridge is now located on what is called Market Street in Brownsville. Originally constructed for \$39,000, the renovation was budgeted for \$3.7 million.

Ironclads for the Navy

Pittsburgh and Cincinnati have good river transportation to the South for their manufactured goods, and for raw cotton coming to Maryland mills. That mostly ended when the Civil War broke out. The impact on John Snowdon's facility was devastating. He continued to ship iron products south, but the payment came back in Confederate money of no value. He stopped the shipments and looked around for another line of products to keep the cash flowing. He partnered with a local shipbuilder, Mason, to get in on the lucrative war effort in the North. The battle of Hampton Roads had marked the demise of the wooden navies. Mason had only built wooden ships for the river traffic, and Snowdon's Iron facility was too small. They closed their Brownsville operations, and bought some riverfront land in Pittsburgh, next to their major iron supplier Lyon, Shorb & Co. Snowdon brought his best workmen and foremen to the new facility. They had a machine shop on the waterfront, and another in the City. They received contracts for two of the new riverine monitors that the Navy needed, and went on to deliver the *Manayunk* and *Umpqua* from their "Gunboat Yard." Snowdon, aided by his son William, ran the facility. He sent his foreman of boilermakers to New York City to confer with Ericsson, the builder of the iconic *Monitor*.

There was a boilershop at the facility, and a skilled boilermaker could make as much as \$3 per day. One of these, Lewis Brown, a wounded veteran of the Gettysburg Campaign, left to a rival who offered him \$5 per day. Snowdon had to deal with skilled labor shortages, and went so far as to return to England to recruit

workers. The *Manayunk* required some 243 skilled workers. Its guns came from Pittsburgh. Multiple changes to the ships were ordered by the government, based on lessons-learned in battle. One of these involved moving the turret, and upgrading the deck armor.

The ship was ready in April of 1864, but the low level of the river prevented launching. It was successfully launched on December 18, 1864, and eventually made its way down the Ohio to New Orleans, to join the Union fleet in 1864. The current was strong, and the large tug *Panther* was required to control it, for a rental fee of \$7,000. Snowdon sent 400 tons of ship fittings separately. The trial run was in September of 1865, and it was accepted by the Navy. It was commissioned in September of 1865. The ironclad was assigned to the North Atlantic Squadron, and later based at Key West in 1871. It spent a few years at the Philadelphia Navy Yard, and at Port Royal, South Carolina.

The other ship, *Umpquo*, wasn't launched until December of 1865, after the war ended. It was never commissioned.

There was an overcapacity of boat building facilities after the war, most on or near the coast. In addition, most builders were in litigation with the government about contract terms and payments. Snowdon dissolved the Company in May of 1867, and left Pittsburgh. Mason had died in 1866. A Sheriff's sale of the machine and shop and iron works in Pittsburgh was held to satisfy debts, while the government litigation dragged on. Snowdon & Son, a new company, went back to a machine shop and rolling mill in Brownsville. In 1867, Snowdon retired, and his sons continued the business, and the litigation. The Claims against the government for payment took 20 years to resolve. John N. Snowdon, the surviving partner, got a monetary award 30 years later, in 1893. For the two boats, he received \$118,000 and \$91,000.

Details on the ships

The Umpqua was laid down in March 1863, and launched in 1865. It was laid up at Mound City, IL. It had a single turret and

displaced 1,194 tons. It was 225 feet long, with a 45 foot beam, and 6-foot draft. This class of ship was built with ballast tanks, to allow it to sit lower in the water, after it reached its destination. The ship was sold in New Orleans in 1874 to Nathaniel McKay, and probably scrapped.

The Manayunk, later renamed Ajax, missed action in the Civil War, but was commissioned in 1869. She served with the North Atlantic Squadron from 1874-1875. She went back into the reserve fleet in 1891. During the Spanish-American War, she was tasked with defending Baltimore. She was decommissioned and scrapped in 1899.

Manayunk was 224 and ½ feet long with a beam of 43 feet. Her maximum draft was just over 13 feet. She weighed a little over 1,000 tons. She had a crew of 100, and a dual cylinder steam engine, fed by 2 boilers. The engine drove a single propeller. With 320 horsepower, she had a speed of 8 knots. Her armament was two smoothbore 15 inch Dahlgren cannon. Each of these weighed 43,000 pounds, and could send a 350 pound shell to 2,100 yards. The wooden hull was protected by 5 layers of 1 inch iron plate. The turret and pilot house had 10 layers of 1 inch plate iron. The deck armor was 1.5 inches thick From lessons learned at the siege of Charleston, the ship had an iron band around the base of the turret to prevent shell fragments from jamming the mechanism. Another lesson learned and applied was the addition of a “rifle screen” at the top of the turret.

Afterword

No direct connection between the Brownsville Snowdon and the Maryland Snowden have been found to date. In Wales, there is a railway going up a mountain, both named Snowdon. This remains the subject of ongoing research.

Appendix

1748 Indenture setting up the Iron Works. Maryland State Archives, Provincial Court Land Records, 1749-1756.

(The author has reformatted this section, but has left the original spelling and punctuation intact).

This Indenture made this 2.th Day of March Seventeen hundred and forty nine Between Edmund Jenings of the City of Annapolis Esq.r of the one Part and Richard Snowden of Ann Arundel County Iron Master of the other Part Whereas by certain Articles of Agreement bearing Date the fifth Day of July Seventeen Hundred and thirty six made Between the said Richard Snowden the sad Edmund Jenings a certain John Galloway Joseph Cowman and John Prichard They the said Richard Snowden Edmund Jenings John Galloway Joseph Cowman and John Prichard did Enter into several Covenants and Clauses of Agreement with each other for the Carrying on an Iron Work or Works and the Business of a Furnace and Forge then and now Erected on the Head and Branches of Patuxent River And for which Purpose the said Richard Snowden did Agree to Convey in fee simple Ten Thousand One Hundred Acres of Land in the said Recited Articles mentioned And Whereas several other Tracts and Parcels of Land from Thomas Linthicum and Edward and Margarett Gaither as well as slaves Horses Waggons and other Materials and Implements Have been Purchased for the use and Purpose of carryingon the said Works But no Deed or Deeds Have been made by the said Richard Snowden in Pursuance of the said Articles whereby the Estate of the said Lands and Buildings thereon still Remain in him Now this Indenture Witnesseth That the said Edmund Jeningsfor and in Consideration of the Sum of Four Hundred and five Pounds Sterling as also of the Covenants herein after mentioned Hath Granted Bargained Sold Aliened Released Transferred and Confirmed and by these Presents Doth Grant Bargain Sell Alien Release Transfer and Confirm unto the said Richard Snowden his Heirs Executors Administrators and Assigns All the Share and Proportion of him the said Edmund Jenings of to and in all

and every the Tracts and Parcells of Land and the Buildings and Improvements as well those Contained in the said Articles as those which have been heretofore Purchased or Contracted for and made for the use of the said Works and of in and to all and every the Slaves Horses Waggon Materials Implements or any other thing whatsoever which have been Bought or Purchased for the use of the said Works And all the Estate Right Title Interest Property or Claim whatsoever of him the said Edmund Jenings either in Law or Equity of in to the same and every part thereof To have and to hold the said Premisses to the said Richard Snowden his Heirs Exors, Administrators and Assigns to his and their own Sole use and Benefit And the said Richard Snowden Doth hereby for himself his Heirs Executors Admrs and Assigns Covenant Promise and Grant to and with the said Edmund Jenings his Heirs and Assigns That he the said Richard Snowden shall as soon as Conveniently may be Survey Run and lay out Two Hundred Acres of Wood Land in Prince Georges County on the Southside of Patuxent Branch over against the Plantation or Quarter of the said Edmund Jenings in Ann Arundel County in such a figure so as such a Quantity thereof at Least shall Run with and Adjoyn to the said Branch as might be Contained within one side of an Exact Square of the whole and in which said Two Hundred Acres he the said Richard Snowden shall Convey a good Estate in fee Simple to the said Edmund Jenings And the said Richard Snowden Doth hereby for himself his Heirs Exors Adm.rs and Assigns Covenant Promise and Agree to and with the said Edmund Jenings his Heirs Exors Adm.rs and Assigns That the said Richard Snowden his Heirs Exors Adm.rs and Assigns shall and will Save harmless and Indemnify him the said Edmund Jenings his Heirs Exors Adm.rs and Assigns of and from all Debts or Demands whatsoever for or on Account of the said Iron Works or Partnership therein And the said Edmund Jenings for himself his Heirs Exors Adm.r and Assigns Doth Covenant Promise and Agree to and with the said Richard Snowden his Heirs Exors Adm.rs and Assigns That he the said Edmund Jenings his Heirs Executors Adm.rsor Assigns shall and will at the Reasonable Request and Charges of the said Richard Snowden his Heirs Exors

Adm.rs or Assigns make and Execute any further Act Deed or Conveyance for the Purposes as afs.dso as same shall contain only a Special Warranty In Witness whereof the Partys afs.d have hereunto Interchangeably set their Hands and Affixed their Seals the Day and Year fist above

written Edm Jenings Seal
Sealed and delivered

Rich.d Snowden
Seal in Presence of Jn. oBrie.

On the Back of the foregoing Deed was thus Endorsed Viz.t Signed Sealed and Delivered (The words from Thomas Linthicum & Edward & Margaret Gaither And also the words as well those contained in the s.d Articles As those being first interlined the Presence of Jn.o Brice.

On the 27. of March 1748 before me the Subscriber one of his Lordships Justices of the Provincial Court personally appeared the within named Edmund Jenings Esq.r and acknowledged the within Instrument of Writing to be his Act and Deed and the Lands and Chattles therein mentioned to be the Right and Estate of the within Named Richard Snowden Heirs and Assigns for Ever according to the true Intent and meaning of the same Deed the Act of Assembly in that case made and Provided Jn.o Brice.

Received the Day and Year within mentioned of the within Named Richard Snowden 405 the Sum of four Hundred and five Pounds Sterl being the Consid.n Money within mentioned I say reced P me

Edm Jenings Witness
Jn.o Brice
9 ½
Recorded September the 19th 1749.

Ex.d This Indenture made this Twenty Eighth Day of March

Seventeen hundred and forty eight Between Joseph Cowman of Ann Arundel County Gent of the one part Richard Snowden of the same County Iron Master of the other part Whereas by certain Articles of Agreement bearing Date the fifth Day of July seventeen Hundred and five made between the said Richard Snowden the said Joseph Cowman a certain Edmund Jenings John Galloway and John Prichard They the said Richard Snowden Joseph Cowman Edmund Jenings John Galloway and John Prichard did enter into several Covenants and Clauses of Agreement with each other for the Carrying on an Iron Work or Works the Business of a Furnace and Forge then and now Erected on the Head and Branches of Patuxent River And for which Purposes the said Richard Snowden Agree to Convey in Fee Simple Ten Thousand One Hundred Acres of Land in the said Articles mentioned And Whereas several other Tracts and Parcels of Land from Thomas Linthicum and Edward and Margaret Gaither as well as Slaves Horses Waggon other Materials and Implements have been Purchased for the Use and Purpose of on the said Works But no Deed or Deeds have been made by the said Richard Snowden in Pursuance of the said Articles whereby the Estate of the said Lands and Buildings thereon still Remain in him Now this Indenture Witnesseth that the said Joseph Cowman for and in Consideration of Four Hundred and five Pounds Current Money Hath Granted Bargained Sold Aliened Transferred Released and Confirmed And by these Presents Doth Bargain Sell Alien Transferr Release and Confirm unto the said Richard Snowden his Heirs Ex.rs Adm.r and Assigns all the share and Proportion of him the said Joseph Cowman of to and in all and every the Tracts and Parcels of Land and the Buildings and Improvements as well those Contained in the said Articles as those which have been heretofore Contracted for and made for the use of the said Works and of and into all and every the Slaves Horses Waggon Materials and Implements or any other thing whatsoever which have been bought or Purchased for the use of the said Works And all the Estate Right Title Interest property or Claim whatsoever of him the said Joseph Cowman either in Law or Equity of in or to the same and every part thereof To have and to hold the said Premisses to the said Richard

Snowden his Heirs Exors Adm.rs and Assigns and Assigns to his and their Sole use and Benefit And the said Richard Snowden for himself his Heirs Exors Adm.rs and Assigns Doth Covenant Promise and Grant to and with the said Joseph Cowman That he the said Richard Snowden his Heirs Exors Adm.rs and Assigns shall and will save harmless and Indemnified him the said Joseph Cowman his Heirs Exors Adm.rs and Assigns of and from all Debts and Demands whatsoever Due for or on Account of the said Iron Works or Partnership And the said Joseph Cowman for himself his Heirs Exors Adm.rs and Assigns Doth Promise and Grant to & with the said Richard Snowden his Heirs Exors Adm.rs and Assigns that he the said Joseph Cowman his Heirs Exors Adm.rs & Assigns shall and will at the Request and Charges of the said Richard Snowden his Heirs Exors Adm.rs & Assigns make and Execute any further Act and Deed or Conveyance for the Purposes as aforesaid so as the same shall Contain only a Special Warranty In Witness whereof the said Parties have hereto Interchangeably set their Hands and Seals the day and Year above written .

Joseph Cowman Seal

Signed Sealed and Delivered

Richd Snowden Sealin the Presence of Jno Brice
Nich.s Maccubbin

On the Back of the foregoing Deed was thus Endorsed Viz.

March 27th 1749 Received the Sum of four Hundred and five Pounds Current Money being the Consideration within mentioned P Testes Joseph Cowman Nich.s Maccubbin

On the 27th day of March 1749 Came the within named Joseph Cowman before me the Subscriber one of his Lordships Provincial Justices and acknowledged the within Instrument of Writing to be his Act and Deed and the Lands and Chattels therein mentioned to be the Right and Estate of the within named Richard Snowden his Heirs and Assigns for Ever according to the true Intent and

meaning of the same Deed and 7 1/2 the Act of Assembly in that case made and Provided.

Jn.o			Brice
Recorded	September	19.th	1749

Ex.d This Indenture made this Second day of October One Thousand seven Hundred forty and Nine Between Daniel Burneets of Baltimore County Cooper on the one part and Charles Carroll of Annapolis in Ann Arundell County Chyrurgeon on the other Part Witnesseth that the said Daniel Burneets for and in Consideration of the Sum of One Hundred and twenty Pounds Sterling Money of Maryland to him in hand paid and Satisfied at and before the Ensealing and Delivery of these presents the Receit whereof he doth hereby acknowledge Hath Bargained Sold Aliened Enfeoffed and Confirmed unto him the said Charles Carroll and by these Presents doth Absolutely give grant Bargain Sell Alien Enfeoffe and Confirm unto him the said Charles two Lotts of Ground belonging to him the said Daniel Situate and being in Baltimore Town in Baltimore County aforesaid with the Buildings Improvements and Appurtenances on the same two Lotts being belonging and Appertaining To have and to hold unto him the said Charles Carroll his Heirs and Assigns for Ever the said two Lotts of Land or Ground with the Buildings Improvements and Appurtenances in the said Baltimore Town or Patapsco River in Baltimore County afs.d And the said Daniel Barneets doth Covenant and Agree with the said Charles Carroll that he the said Charles Carroll his Heirs and Assigns for Ever the said two Lotts of Ground with the Buildings and Improvements shall and may have Possess and Enjoy well and fully Warranted and Defended as well against him the said Daniel Barneets as against all manner of Persons and Claims whatsoever Provided always and it is the true intent and meaning of these Presents that in Case he the said Daniel Carroll at or before the Second Day of May next the Just and full Sum of One Hundred and twenty Pounds Current Money with the Lawfull Interest that then and in such case this Indenture of Bargain and Sale to become Void otherwise to Remain and be in

full force and Virtue In Witness whereof and the foregoing Premisses the said Parties to these presents have Interchangeably set their Hands and Seals the day and Yearts first above written Sealed and Delivered in January Seal Presence of Cha.s Carroll Jun. r At the foot of the foregoing Mortgage was thus written Viz.t Tho.s Williamson

October 2 1749 Then came before me one of the Justices of the Provincial Court Daniel Barneets of Baltimore County party to this Deed and acknowledged the same according to the Directions of the Act of Assembly in that case made and Provided.

Robert Gordon Rec. of Dr. Charles Carroll one Hundred and twenty Pounds the Consideration within mentioned Witness 4 1/2 my Hand Oct.r 2.d1749 Jan. Char Carroll Jun.r Recorded October the 5.th 1749 Tho.s Williamson

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South River Works - This area is covered by the map: U.S. Department of the Interior, U.S. Geological Survey, South River Quadrangle, Maryland, Anne Arundel County.

Wikipedia, various

Glossary

ASIN – Amazon Standard Inventory Number.

Bituminous coal – an organic sedimentary rock of mostly carbon.

Blacksmith – creates items from wrought iron.

Blast furnace – furnace to produce iron from iron, and using a forced blast of air to get better combustion.

Bloom – a porous mass of iron and slag, called sponge iron.

Bloomery – a crude iron production facility for small batches.

Blowing engine – a large cylinder powered by a steam engine to produce the blast for the furnace.

Bog iron – poor quality iron made from ore found in swampy areas.

Bosh - lower part of a blast furnace, between the hearth and the stack. Hottest place in the furnace

Chafery – a reheating hearth, to work pig iron into wrought iron.

Charcoal – produced by heating wood in the absence of oxygen; nearly pure carbon.

Coal – a mineral, mostly carbon, with a variety of other trace elements.

Coal gas – by-product of coke production

Coke – produced by destructive distillation of coal. Is mostly pure carbon.

Finery forge – facility to produce wrought iron from pig iron, by removing carbon.

Fire clay – silica and alumina.

Flux – material to bind with and capture the impurities in the iron ore.

Forge – a heating furnace with forced draft, fueled by charcoal or coal.

Founder – worker in molten metal; supervisor of a furnace.

Hematite – iron ore, predominate in Western Maryland

Iron - element number 26.

ISBN – international standard book number.

Limestone – sedimentary rock, calcium carbonate.

Open Hearth Furnace – converts pig iron to steel. Replacement for

the Bessemer furnace.

Pig iron – iron ore with the oxygen removed. Iron ore is rust – iron bonded with Oxygen.

Puddlers candle – bubbles of carbon monoxide produced in a puddling furnace. Burst and catch fire at the surface.

Puddling furnace – converts pig iron to steel or wrought iron. Hot air passes over the molten iron.

Pyrolysis – heating in the absence of oxygen to drive off contaminants

Reducing agent – removes oxygen from a material. Carbon monoxide is used with iron.

Reduction process – opposite of oxidation. Oxygen is removed.

Reverberatory furnace – used to make iron and mild steel. The molten iron is isolated from contact with the fuel, but does contact the combustion gases.

Rolling Mill – process to shape hot iron into long sheets or bars by squeezing between rollers.

Siderite – iron carbonate, common in Prince Georges County.

Siemens regenerative furnace – circa 1865 open hearth furnace design.

Slag – the impurities extracted from the iron ore; a glassy material when cooled.

Smelting - extraction technique in metallurgy to produce metal from ore.

Steel – iron with a carbon percentage of 0.2 to 2.14%. Stronger than iron.

Tuyeres – nozzles to introduce the blast into the furnace. Usually, water-cooled.

Wrought iron – pig iron worked to reduce contaminants and carbon.

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